Antenna Standards										
Frequency (MHz)	Category	Maximumbeamwidth to 3 dB points (included angles in degrees)	Minimumantenna gain (dbi)	Minimum radiation suppression to angle in degrees from centerline of main beam in decibels						
				5° to 10°	10° to 15°	15° to 20°	20° to 30°	30° to 100°	100° to 140°	140° to 180°
932.5 to 935	A	14.0	n/a		6	11	14	17	20	24
	B	20.0	n/a			6	10	13	15	20
941.5 to 944	A	14.0	n/a		6	11	14	17	20	24
	B	20.0	n/a			6	10	13	15	20
952 to 960 (8) (9)	A	14.0	n/a		6	11	14	17	20	24
	B	20.0	n/a			6	10	13	15	20
1,850 to 2,500 (11)	A	5.0	n/a	12	18	22	25	29	33	39
	B	8.0	n/a	5	18	20	20	25	28	36
3,700 to 4,200	A	n/a	36	23	29	33	36	42	55	55
	B	n/a	36	20	24	28	32	32	32	32
5,925 to 6,425 (5)	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	21	25	29	32	35	39	45
5,925 to 6,425 (6)	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	20	24	28	32	35	36	36
6,525 to 6,875 (5)	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	21	25	29	32	35	39	45
6,525 to 6,875 (6)	A	1.5	n/a	26	29	32	34	38	41	49
	B	2.0	n/a	21	25	29	32	35	39	45
10,550 to 10,680 (4) (5)	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	20	24	28	32	35	35	39
10,550 to 10,680 (6)	A	3.4	34	20	24	28	32	35	55	55
	B	3.4	34	20	24	28	32	35	35	39
10,565 to 10,615 (7)	n/a	360	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10,630 to 10,680 (7)	n/a	n/a	34	20	24	28	32	35	36	36
10,700 to 11,700 (5)	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	20	24	28	32	35	36	36
12200 to 13250 (12)	A	1.0	n/a	23	28	35	39	41	42	50
	B	2.0	n/a	20	25	28	30	32	37	47
17,700 to 18,820	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	20	24	28	32	35	36	36

18.920 to 19.700 (1)	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	20	24	28	32	35	36	36
21.200 to 23.600 (10)	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	20	24	28	32	35	36	36
31.000 to 31.300 (2) (3)	n/a	4.0	38	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Above 31.300	A	n/a	38	25	29	33	36	42	55	55
	B	n/a	38	20	24	28	32	35	36	36

(1) DEMS User Station antennas in this band must meet performance Standard B and have a minimum antenna gain of 34 dBi. The maximum beamwidth requirement does not apply to DEMS User Stations DEMS Nodal Stations need not comply with these standards.

(2) The minimum front-to-back ratio must be 38 dBi.

(3) Mobile, except aeronautical mobile, stations need not comply with these standards.

(4) Except for antennas between 140° and 180° authorized or pending on January 1, 1989, in the band 10,550 to 10,565 MHz for which minimum radiation to suppression to angle (in degrees) from centerline of main beam is 36 decibels.

(5) These antenna standards apply to all point-to-point stations authorized after June 1, 1997. Existing licensees and pending applicants on that date are grandfathered and need not comply with these standards.

(6) These antenna standards apply to all point-to-point stations authorized on or before June 1, 1997.

(7) These antenna standards apply only to DEMS User Stations licensed, in operation, or applied for prior to July 15. 1993.

(8) Except for Multiple Address System frequencies listed in where omnidirectional antennas may be used.

(9) Antennas used at outlying stations as part of a central protection alarm system need conform to only the following 2 standards: (1) The minimum on-beam forward gain must be at least 10 dBi, and (2) the minimum front-to-back ratio must be at least 20 dB.

(10) Except as provided in § 101.147(t).

NOTE: Stations must employ an antenna that meets the performance standards for Category A, except that in areas not subject to frequency congestion, antennas meeting standards for Category B may be employed. Note, however, that the Commission may require the use of high performance antennas where interference problems can be resolved by the use of such antennas.

(11) Omnidirectional antennas may be authorized in the band 2150 - 2160 MHz.

(12) Except for temporary-fixed operations in the band 13200 - 13250 MHz with output powers less than 250 mW and as provided in § 101.147(q).

(d) The Commission shall require the replacement of any antenna or periscope antenna

system of a permanent fixed station operating at 932.5 MHz or higher that does not meet performance Standard A specified in paragraph (c) of this Section, at the expense of the licensee operating such antenna, upon a showing that said antenna causes or is likely to cause interference to (or receive interference from) any other authorized or applied for station whereas a higher performance antenna is not likely to involve such interference. Antenna performance is expected to meet the standards of paragraph (c) of this Section for parallel polarization. For cases of potential interference, an antenna will not be considered to meet Standard A unless the parallel polarization performance for the discrimination angle involved meets the requirements, even if the cross-polarization performance controls the interference.

(e) In cases where passive reflectors are employed in conjunction with transmitting antenna systems, the foregoing paragraphs of this section also will be applicable. However, in such instances, the center of the major lobe of radiation from the antenna normally must be directed at the passive reflector, and the center of the major lobe of radiation from the passive reflector directed toward the receiving station with which it communicates.

(f) Periscope antennas used at an electric power facility plant area will be excluded from the requirements of paragraph (c) of this section on a case-by-case basis where technical considerations or safety preclude the use of other types of antenna systems.

(g) In the event harmful interference is caused to the operation of other stations, the Commission may, after notice and opportunity for hearing, order changes to be made in the height, orientation, gain and radiation pattern of the antenna system.

§ 101.117 Antenna polarization.

Except as set forth herein, stations operating in the radio services included in this part are not limited as to the type of polarization of the radiated signal, provided, however, that in the event interference in excess of permissible levels is caused to the operation of other stations the Commission may, after notice and opportunity for hearing, order the licensee to change the polarization of the radiated signal. No change in polarization may be made without prior authorization from the Commission. Unless otherwise allowed, only linear polarization (horizontal or vertical) shall be used.

§ 101.119 Simultaneous use of common antenna structures.

The simultaneous use of common antenna structures by more than one radio station, or by one of more domestic public radio stations and one or more stations of any other class or service, may be authorized: Provided, however, that each licensee or user of any such structure is responsible for maintaining the structure, and for painting and illuminating the structure when obstruction marking is required by the Commission. (See § 101.21(a).)

§ 101.121 Marking of antenna structures.

The owner of each antenna structure required to be painted and/or illuminated under the provision of § 303(q) of the Communications Act of 1934, as amended, shall operate and maintain the antenna structure painting and lighting in accordance with Part 17 of this chapter. In the event of default by the owner, each licensee or permittee shall be individually responsible for conforming to the requirements pertaining to antenna structure painting and lighting. For complete regulations relative to antenna marking requirements, see Part 17 of this chapter.

§ 101.123 Quiet zones.

Quiet zones are those areas where it is necessary to restrict radiation so as to minimize possible impact on the operations of radio astronomy or other facilities that are highly sensitive to radio frequency interference.

(a) In order to minimize possible harmful interference at the National Radio Astronomy Observatory site located at Green Bank, Pocohontas County, W. Va., and at the Naval Radio Research Observatory site at Sugar Grove, Pendleton County, W. Va., any applicant for a station authorization other than temporary-fixed seeking a station license for a new station or to modify an existing station in a manner which would change either the frequency, power, antenna height or directivity, or location of such a station within the area boarded by 39°15' N. on the north, 78°30' W. on the east, 37°30' N. on the south, and 80°30' W. on the west must at the time of filing such application with the Commission, simultaneously notify the Director, National Radio Astronomy Observatory, Post Office Box No. 2, Green Bank, W. Va. 24944, in writing, of the technical particulars of the proposed station. Such notification must include the geographical coordinates of the antenna, antenna height, antenna directivity if any, proposed frequency, type of emission and power. In addition, the applicant must indicate in his application to the Commission the date notification was made to the Observatory. After receipt of such applications, the Commission will allow a period of twenty (20) days for comments or objections in response to the notifications indicated. If an objection to the proposed operation is received during the 20-day period from the National Radio Astronomy Observatory for itself or on behalf of the Naval Radio Research Observatory, the Commission will consider all aspects of the problem and take whatever action is deemed appropriate.

(b) Protection for Table Mountain Radio Receiving Zone, Boulder County, Colorado. Applicants for a station authorization to operate in the vicinity of Boulder County, Colorado under this part are advised to give due consideration, prior to filing applications, to the need to protect the Table Mountain Radio Receiving Zone from harmful interference. These are the research laboratories of the Department of Commerce, Boulder County,

Colorado. To prevent degradation of the present ambient radio signal level at the site, the Department of Commerce seeks to ensure that the field strengths of any radiated signals (excluding reflected signals) received on this 1800 acre site (in the vicinity of coordinates 40°07'50" N. Latitude, 105°14' 40" W. Longitude), resulting from new assignments or from the modification or relocation of existing facilities do not exceed 1 mV/m in the authorized bandwidth of service. (A field strength of 1 mV/m is equivalent to a power flux density of 85.8 dBW/M^2 assuming a free-space characteristic impedance of 376.7 ohms.)

(1) Advance consultation is recommended particularly for those applicants who have no reliable data which indicates whether the field strength or power flux density figures would be exceeded by their proposed radio facilities. In such instances, the following is a suggested guide for determining whether coordination is recommended:

(i) All stations within 2.4 km;

(ii) Stations within 4.8 km with 50 watts or more effective radiated power (ERP) in the primary plane of polarization in the azimuthal direction of the Table Mountain Receiving Zone;

(iii) Stations within 16 km with 1 kW or more ERP in the primary plane of polarization in the azimuthal direction of the Table Mountain Receiving Zone;

(iv) Stations within 80 km with 25 kW or more ERP in the primary plane of polarization in the azimuthal direction of the Table Mountain Receiving Zone.

(2) Applicants concerned are urged to communicate with the Radio Frequency Management Coordinator, Department of Commerce, Research Support Services, NOAA/R/E5X2, Boulder Laboratories, Boulder CO. 80303; telephone (303) 497-6548, in advance of filing their applications with the Commission.

(3) The Commission will not screen applications to determine whether advance consultation has taken place. However, applicants are advised that such consultation can avoid objections from the Department of Commerce or proceedings to modify any authorization which may be granted which, in fact, delivers a signal at the site in excess of the field strength specified herein.

(c) Protection for Federal Communications Commission monitoring stations:

(1) Applicants in the vicinity of an FCC monitoring station for a radio station authorization to operate new transmitting facilities or changed transmitting facilities which would increase the field strength produced over the monitoring station over that previously authorized are advised to give consideration, prior to filing applications, to the possible need

to protect the FCC stations from harmful interference. Geographical coordinates of the facilities which require protection are listed in § 0.121(c) of the Commission's Rules. Applications for stations (except mobile stations) which will produce on any frequency a direct wave fundamental field strength of greater than 10 mV/m in the authorized bandwidth of service (-65.8 dBW/m^2 power flux density assuming a free space characteristic impedance of 120 ohms) at the referenced coordinates, may be examined to determine extent of possible interference. Depending on the theoretical field strength value and existing root-sum-square or other ambient radio field signal levels at the indicated coordinates, a clause protecting the monitoring station may be added to the station authorization.

(2) In the event that calculated value of expected field exceeds 10 mV/m (-65.8 dBW/m^2) at the reference coordinates, or if there is any question whether field strength levels might exceed the threshold value, advance consultation with the FCC to discuss any protection necessary should be considered. Prospective applicants may communicate with: Chief, Compliance and Information Bureau, Federal Communications Commission, Washington, D.C. 20554, Telephone (202) 418-1100.

(3) Advance consultation is suggested particularly for those applicants who have no reliable data which indicates whether the field strength or power flux density figure indicated would be exceeded by their proposed radio facilities (except mobile stations). In such instances, the following is a suggested guide for determining whether an applicant should coordinate:

(i) All stations within 2.4 kilometers;

(ii) Stations within 4.8 kilometers with 50 watts or more average effective radiated power (ERP) in the primary plane of polarization in the azimuthal direction of the Monitoring Stations.

(iii) Stations within 16 kilometers with 1 kW or more average ERP in the primary plane of polarization in the azimuthal direction of the Monitoring Station;

(iv) Stations within 80 kilometers with 25 kW or more average ERP in the primary plane of polarization in the azimuthal direction of the Monitoring Station;

(4) Advance coordination for stations operating above 1000 MHz is recommended only where the proposed station is in the vicinity of a monitoring station designated as a satellite monitoring facility in § 0.121(c) of the Commission's rules and also meets the criteria outlined in paragraphs (i) (2) and (3) of this section.

(5) The Commission will not screen applications to determine whether advance consultation has taken place. However, applicants are advised that such consultation can avoid objections from the Federal Communications Commission or modification of any authorization which will cause harmful interference.

§ 101.125 Temporary fixed antenna height restrictions.

The overall antenna structure heights employed by mobile stations in the Local Television Transmission Service and by stations authorized to operate at temporary fixed locations may not exceed the height criteria set forth in § 17.7 of this chapter, unless in each instance, authorization for use of a specific maximum antenna height (above ground and above mean sea level) for each location has been obtained from the Commission prior to erection of the antenna. Requests for such authorization must show the inclusive dates of the proposed operation. (Complete information as to rules concerning the construction, marking and lighting of antenna structures is contained in Part 17 of this chapter.)

§ 101.127 Topographical data.

Determining the location and height above sea level of the antenna site, the elevation or contour intervals must be taken from United States Geological Survey Topographic Quadrangle Maps, United States Army Corps of Engineers maps or Tennessee Valley Authority maps, whichever is the latest, for all areas for which such maps are available. If such maps are not published for the area in question, the next best topographic information should be used. Topographic data may sometimes be obtained from State and municipal agencies. Data from Sectional Aeronautical Charts (including bench marks) or railroad depot elevations and highway elevations from road maps may be used where no better information is available. In cases where limited topographic data is available, use may be made of an altimeter in a car driven along roads extending generally radially from the transmitter site. If it appears necessary, additional data may be requested. United States Geological Survey Topographic Quadrangle Maps may be obtained from the Department of the Interior, Geological Survey, Washington, DC 20242. Sectional Aeronautical Charts are available from the Department of Commerce, Coast and Geodetic Survey, Washington, DC 20230.

§ 101.129 Transmitter location.

(a) The applicant must determine, prior to filing an application for a radio station authorization, that the antenna site specified therein is adequate to render the service proposed. In cases of questionable antenna locations, it is desirable to conduct propagation tests to indicate the field intensity which may be expected in the principal areas or at the fixed points of communication to be served, particularly where severe shadow problems may be expected. In considering applications proposing the use of such locations, the Commission may require site survey tests to be made pursuant to a developmental authorization in the particular service concerned. In such cases, propagation tests should be conducted in accordance with recognized engineering methods and should be made with a transmitting antenna simulating, as near as possible, the proposed antenna installation. Full data obtained from such surveys and its analysis, including a description of the methods used and the name, address and qualifications of the engineer making the survey, must be supplied to the Commission.

(b) Antenna structures should be so located and constructed as to avoid making them

hazardous to air navigation. (See Part 17 of this chapter for provisions relating to antenna structures.) Such installation must be maintained in good structural condition together with any required painting or lighting.

§ 101.131 Transmitter construction and installation.

(a) The equipment at the operating and transmitting positions must be so installed and protected that it is not accessible to, or capable of being operated by, persons other than those duly authorized by the licensee.

(b) In any case where the maximum modulating frequency of a transmitter is prescribed by the Commission, the transmitter must be equipped with a low-pass or band-pass modulation filter of suitable performance characteristics. In those cases where a modulation limiter is employed, the modulation filter must be installed between the transmitter stage in which limiting is effected and the modulated stage of the transmitter.

(c) Each transmitter employed in these services must be equipped with an appropriately labeled pilot lamp or meter which will provide continuous visual indication at the transmitter when its control circuits have been placed in a condition to activate the transmitter. In addition, facilities must be provided at each transmitter to permit the transmitter to be turned on and off independently of any remote control circuits associated therewith.

(d) At each transmitter control point the following facilities must be installed:

(1) A carrier operated device which will provide continuous visual indication when the transmitter is radiating, or, in lieu thereof, a pilot lamp or meter which will provide continuous visual indication when the transmitter control circuits have been placed in a condition to activate the transmitter.

(2) Facilities which will permit the operator to turn transmitter carrier on and off at will.

(e) Transmitter control circuits from any control point must be so installed that grounding or shorting any line in the control circuit will not cause the transmitter to radiate: Provided, however, That this provision will not be applicable to control circuits of stations which normally operate with continuous radiation or to control circuits which are under the effective operational control of responsible operating personnel 24 hours per day.

§ 101.133 Limitations on use of transmitters.

(a) Transmitters licensed for operation in Common Carrier services may be concurrently licensed or used for non-common carrier communication purposes. Mobile units may be concurrently licensed or used for non-common carrier communication purposes provided that the transmitter is type-accepted for use in each service.

(b) Private operational fixed point-to-point microwave stations authorized in this service may communicate with associated operational-fixed stations and fixed receivers and with units of associated stations in the mobile service licensed under Private Radio Service rule parts. In addition, intercommunication is permitted with other licensed stations and with U.S. Government stations in those cases which require cooperation or coordination of activities or when cooperative use arrangements in accordance with § 101.135 are contemplated; provided, however, that where communication is desired with stations authorized to operate under the authority of a foreign jurisdiction, prior approval of this Commission must be obtained; And provided further, That the authority under which such other stations operate does not prohibit the intercommunication.

(c) Two or more persons or governmental entities eligible for private operational fixed point-to-point microwave licenses may use the same transmitting equipment under the following terms and conditions:

(1) Each licensee complies with the general operating requirements set out in this Part.

(2) Each licensee is eligible for the frequency(ies) on which the facility operates.

(3) Each licensee must have the ability to access the transmitter(s) that it is authorized to operate under the multiple licensing arrangement.

§ 101.135 Shared use of radio stations and the offering of private carrier service.

(a) Licensees of Private Operational Fixed Point-to-Point Microwave radio stations may share the use of their facilities on a non-profit basis or may offer service on a for-profit private carrier basis, subject to the following conditions and limitations:

(1) Persons or governmental entities licensed to operate radio systems on any of the private radio frequencies set out in § 101.101 may share such systems with, or provide private carrier service to, any eligible for licensing under this part, regardless of individual eligibility restrictions, provided that the communications being carried are permissible under § 101.603. In addition, persons or governmental entities licensed to operate low power systems under the provisions of § 101.147(r)(10) may share such systems with, or provide private carrier services to, Federal Government entities, provided the communications carried are permissible under § 101.603.

(2) The licensee must maintain access to and control over all facilities authorized under its license.

(3) All sharing and private carrier arrangements must be conducted pursuant to a written agreement to be kept as part of the station records.

(4) The licensee must keep an up-to-date list of system sharers and private carrier subscribers and the basis of their eligibility under this part. Such records must be kept current and must be made available upon request for inspection by the Commission.

§ 101.137 Interconnection of private operational fixed point-to-point microwave stations.

Private operational fixed point-to-point microwave stations may be interconnected with facilities of common carriers subject to applicable tariffs.

§ 101.139 Authorization of transmitters.

(a) Except for transmitters used at developmental stations or for fixed point-to-point operation pursuant to Subparts H and I, each transmitter must be a type which has been type accepted by the Commission for use under the applicable rules of this part. Transmitters used in the private operational fixed and common carrier fixed point-to-point microwave services under Subparts H and I must be of a type that has been either notified or type accepted by the Commission (see § 2.904(d) of this chapter). Effective March 5, 1984, only grants of notification will be issued for transmitters used exclusively for fixed point-to-point operation. Transmitters designed for use in the 31.0 to 31.3 GHz band will be authorized under the notification procedure.

(b) Any manufacturer of a transmitter to be produced for use under the rules of this part may request type acceptance or notification by following the applicable procedures set forth in Part 2 of this chapter. Type accepted and notified transmitters are included in the Commission's Radio Equipment List. Copies of this list are available for inspection at the Commission's office in Washington, D.C. and at each of its field offices.

(c) Type acceptance or notification for an individual transmitter may also be requested by an applicant for a station authorization, pursuant to the procedures set forth in Part 2 of this chapter. An individual transmitter will not normally be included in the Radio Equipment List but will be enumerated on the station authorization.

(d) A transmitter presently shown on an instrument of authorization, which operates on an assigned frequency in the 890-940 MHz band and has not been type accepted, may continue to be used by the licensee without type acceptance provided such transmitter continues otherwise to comply with the applicable rules and regulations of the Commission.

(e) Type acceptance or notification is not required for portable transmitters operating with peak output power not greater than 250 mW. If operation of such equipment causes harmful interference the FCC may, at its discretion, require the licensee to take such corrective action as is necessary to eliminate the interference.

(f) After July 15, 1996, the manufacture (except for export) or importation of equipment

employing digital modulation techniques in the 3700-4200, 5925-6425, 6525-6875, 10,550-10,680 and 10,700-11,700 MHz bands must meet the minimum payload capacity requirements of § 101.141.

§ 101.141 Microwave modulation.

(a) Microwave transmitters employing digital modulation techniques and operating below 19.7 GHz must, with appropriate multiplex equipment, comply with the following additional requirements:

(1) The bit rate, in bits per second, must be equal to or greater than the bandwidth specified by the emission designator in Hertz (e.g., to be acceptable, equipment transmitting at a 20 Mb/s rate must not require a bandwidth of greater than 20 MHz), except the bandwidth used to calculate the minimum rate may not include any authorized guard band.

NOTE: Systems authorized prior to December 1, 1988, may install equipment after that date with no minimum bit rate.

(2) Equipment to be used for voice transmission placed in service, authorized, or applied for on or before June 1, 1997 in the 2110 to 2130 and 2160 to 2180 MHz bands must be capable of satisfactory operation within the authorized bandwidth to encode at least 96 voice channels. Equipment placed in service, authorized, or applied for on or before June 1, 1997 in the 3700-4200, 5925-6425 (30 MHz bandwidth), and 10,700-11,700 MHz (30 and 40 MHz bandwidths) bands must be capable of satisfactory operation within the authorized bandwidth to encode at least 1152 voice channels. These required loading levels may be reduced by a factor of 1/N provided that N transmitters may be operated satisfactorily, over the same radio path, within an authorized bandwidth less than, or equal to, the maximum authorizable bandwidth (e.g., the 1152 channel requirement may be reduced to 576 if two transmitters can be satisfactorily operated over the same path within the maximum bandwidth). Where type accepted equipment is designed to operate on the same frequency in a cross polarized configuration to meet the above capacity requirements, the Commission will require, at the time additional transmitters are authorized, that both polarizations of a frequency be used before a new frequency assignment is made, unless a single transmitter installation was found to be justified by the Commission at the time it authorized the first transmitter.

(3) The following capacity and loading requirements must be met for equipment applied for, authorized, and placed in service after June 1, 1997 in the 3700-4200 MHz (4 GHz), 5925-6425 and 6525-6875 MHz (6 GHz), 10,550-10,680 MHz (10 GHz), and 10,700-11,700 MHz (11 GHz) bands:

Nominal Channel Bandwidth (MHz)	Minimum Payload Capacity (Mbits/s) (1)	Minimum Traffic Loading Payload (as percent of payload capacity)	Typical Utilization*
0.400	1.54	n/a	1 DS-1
0.800	3.08	n/a	2 DS-1
1.25	3.08	n/a	2 DS-1
1.60	6.17	n/a	4 DS-1
2.50	6.17	n/a	4 DS-1
3.75	12.3	n/a	8 DS-1
5.0	18.5	n/a	12 DS-1
10.0	44.7	50**	1 DS-3/STS-1
20.0	89.4	50**	2 DS-3/STS-1
30.0 (11 GHz)	89.4	50**	2 DS-3/STS-1
30.0 (6 GHz)	134.1	50**	3 DS-3/STS-1
40.0	134.1	50**	3 DS-3/STS-1

* DS and STS refer to the number of voice circuits a channel can accommodate. 1 DS-1 = 24 voice circuits; 2 DS-1 = 48; 4 DS-1 = 96; 8 DS-1 = 192; 12 DS-1 = 288; 1 DS-3/STS-1 = 672; 2 DS-3/STS-1 = 1344; 3 DS-3/STS-1 = 2016.

** This loading requirement must be met within 30 months of licensing. If two transmitters simultaneously operate on the same frequency over the same path, the requirement is reduced to 25 percent.

(1) Per polarization

(4) If a transmitter is authorized to operate in a bandwidth that is not listed in paragraph (a)(3) of this section, it must meet the minimum payload capacity and traffic loading requirements of the next largest channel bandwidth listed in the table; e.g., if the authorized bandwidth is 3.5 MHz, the minimum payload capacity must be 12.3 Mbits/s.

(5) Transmitters carrying digital motion video motion material are exempt from the requirements specified in paragraphs (a)(2) and (a)(3) of this section, provided that at least 50 percent of the payload is digital video motion material and the minimum bit rate specified in paragraph (a)(1) is met. In the 6, 10, and 11 GHz bands, concatenation of multiple contiguous channels is permitted for channels of equal bandwidth on center frequencies, provided no other channels are available and the minimum payload capacity requirements are met.

(6) Digital systems using bandwidths of 10 MHz or larger will be considered 50 percent loaded when the following condition is met: at least 50 percent of their total DS-1 capacity is being used. A DS-1 channel is being used when it has been connected to a DS-0/DS-1 multiplexer. For non-DS-0 services, such as, but not limited to, video or broadband data transmission, the next largest DS-1 equivalent will be considered for the computation of a loading percentage.

(7) For digital systems, minimum payload capacities shall be expressed in numbers of DS-1s, DS-3s or STS-1s. The payload capacity required by the Commission shall correspond to commercially available equipment.

(b) For purposes of compliance with the emission limitation requirements of § 101.111(a)(2) of this part and the requirements of paragraph (a) of this section, digital modulation techniques are considered as being employed when digital modulation occupies 50 percent or more to the total peak frequency deviation of a transmitted radio frequency carrier. The total peak frequency deviation will be determined by adding the deviation produced by the digital modulation signal and the deviation produced by any frequency division multiplex (FDM) modulation used. The deviation (D) produced by the FDM signal must be determined in accordance with § 2.202(f) of Part 2 of this chapter.

(c) Analog Modulation. Except for video transmission, an application for an initial working channel for a given route will not be accepted for filing where the anticipated loading (within five years for voice, or other period subject to reasonable projection) is less than the minimum specified for the following frequency bands. Absent extraordinary circumstances, applications proposing additional frequencies over existing routes will not be granted unless it is shown that the traffic load will shortly exhaust the capacity of the existing equipment. Where no construction of radio facilities is requested, licensees must submit this evidence with their filing of any necessary authority required pursuant to § 214 of the Communications Act and Part 63 of this chapter.

Frequency Band (MHz)	Minimum Number of Voice Channels (4 KHz or equivalent)
3700 to 4200 (20 MHz bandwidth)	900
5925 to 6425 (10 MHz bandwidth)	300
5925 to 6425 (20 MHz bandwidth)	600
5925 to 6425 (30 MHz bandwidth)	900
6525 to 6875 (10 MHz bandwidth)	300
10,700 to 11,700 (10 MHz bandwidth)	300
10,700 to 11,700 (20 MHz bandwidth)	600
10,700 to 11,700 (30 MHz bandwidth)	900
10,700 to 11,700 (40 MHz bandwidth)	900

§ 101.143 Minimum path length requirements.

(a) The distance between end points of a fixed link in the private operational fixed point-to-point and the common carrier fixed point-to-point microwave services must equal or exceed the value set forth in the table below or the EIRP must be reduced in accordance with the equation set forth below.

Frequency Band (MHz)	Minimum path length (km)
Below 1,850	n/a
1,850 to 7,125	17
10,550 to 13,250	5
Above 17,700	n/a

(b) For paths shorter than those specified in the Table, the EIRP shall not exceed the value derived from the following equation.

EIRP = MAX EIRP - 40*log(A/B) dBW

Where:
EIRP=Equivalent isotropically radiated power in dBW.

A=Minimum path length from the Table for the frequency band in kilometers.
B=The actual path length in kilometers.

NOTE: For transmitters using Automatic Transmit Power Control, EIRP that corresponds to the maximum transmitter power must satisfy this requirement.

(c) Upon an appropriate technical showing, applicants and licensees unable to meet the minimum path length requirement may be granted an exception to these requirements.

NOTE: Links authorized prior to April 1, 1987, need not comply with this requirement.

§ 101.145 Interference to geostationary-satellites.

These limitations are necessary to minimize the probability of harmful interference to reception in the bands 2655-2690 MHz, 5925-6875 MHz, and 12.7-12.75 GHz on board geostationary-space stations in the fixed-satellite service (Part 25).

(a) Stations authorized prior to July 1, 1976 in the band 2655-2690 MHz, which exceed the power levels in paragraphs (a) and (b) of this section are permitted to operate indefinitely, provided that the operations of such stations does not result in harmful interference to reception in these band on board geostationary space stations.

(b) 2655 to 2690 MHz and 5925 to 6875 MHz. No directional transmitting antenna utilized by a fixed station operating in these bands may be aimed within 2 degrees of the geostationary-satellite orbit, taking into account atmospheric refraction. However, exception may be made in unusual circumstances upon a showing that there is no reasonable alternative to the transmission path proposed. If there is no evidence that such exception would cause possible harmful interference to an authorized satellite system, said transmission path may be authorized on waiver basis where the maximum value of the equivalent isotropically radiated power (EIRP) does not exceed:

(1) +47 dBW for any antenna beam directed within 0.5 degrees of the stationary satellite orbit or

(2) +47 to +55 dBW, on a linear decibel scale (8 dB per degree) for any antenna beam directed between 0.5 degrees and 1.5 degrees of the stationary orbit.

(c) 12.7 to 12.75 GHz. No directional transmitting antenna utilized by a fixed station operating in this band may be aimed within 1.5 degrees of the geostationary-satellite orbit, taking into account atmospheric refraction. However, exception may be made in unusual circumstances upon a showing that there is no reasonable alternative to the transmission path proposed. If there is no evidence that such exception would cause possible harmful interference to an authorized satellite system, said transmission path may be authorized on

waiver basis where the maximum value of the equivalent isotropically radiated power (EIRP) does not exceed +45 dBW for any antenna beam directed within 1.5 degrees of the stationary satellite orbit.

(d) Methods for calculating the azimuths to be avoided may be found in: CCIR Report No. 393 (Green Books), New Delhi, 1970; in "Radio-Relay Antenna Pointing for controlled Interference With Geostationary-Satellites" by C. W. Lundgren and A. S. May, Bell System Technical Journal, Vol. 48, No. 10, pp. 3387-3422, December 1969; and in "Geostationary Orbit Avoidance Computer Program" by Richard G. Gould, Common Carrier Bureau Report CC-7201, FCC, Washington, DC, 1972. This latter report is available through the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22151, in printed form (PB-211 500) or source card deck (PB-211 501).

§ 101.147 Frequency assignments.

(a) Frequencies in the following bands are available for assignment to fixed radio point-to-point microwave stations.

928.0 - 929.0 MHz /22/
932.0 - 932.5 MHz /27/
932.5 - 935 MHz /17/
941.0 - 941.5 MHz /17/ /18/
941.5 - 944 MHz /27/
952.0 - 960.0 MHz /22/
1,850 - 1,990 MHz /22/
2,110 - 2,130 MHz /1/ /3/ /7/ /20/
2,130 - 2,150 MHz /22/
2,150 - 2,160 MHz /22/
2,160 - 2,180 MHz /1/ /2/ /20/ /21/
2,180 - 2,200 MHz /22/
2,450 - 2,500 MHz /22/
2,650 - 2,690 MHz /22/
3,700 - 4,200 MHz /8/ /14/ /25/
5,925 - 6,425 MHz /6/ /14/ /25/
6,425 - 6,525 MHz /24/
6,525 - 6,875 MHz /14/
10,550 - 10,680 MHz /19/
10,700 - 11,700 MHz /8/ /9/ /19/ /25/
11,700 - 12,200 MHz /24/
12,200 - 12,500 MHz /22/
12,500 - 12,700 MHz /22/
12,700 - 13,200 MHz /22/
13,200 - 13,250 MHz /4/ /24/ /25/
14,200 - 14,400 MHz /24/

17,700 - 18,820 MHz /5/ /10/ /15/
18,820 - 18,920 MHz /22/
18,920 - 19,160 MHz /5/ 10/ /15/
19,160 - 19,260 MHz /22/
19,260 - 19,700 MHz /5/ /10/ /15/
21,200 - 22,000 MHz /4/ 11/ /12/ /13/ /24/ /25/ /26/
22,000 - 23,600 MHz /4/ /11/ /12/ /24/ /25/ /26/
27,500 - 29,500 MHz /5/
31,000 - 31,300 MHz /16/ /24/
38,600 - 40,000 MHz /4/
Bands Above 40,000 MHz

/1/ Frequencies in this band are shared with control and repeater stations in the Domestic Public Land Mobile Radio Service and with stations in the International Fixed Public Radiocommunication Services located south of 25° 30' north latitude in the State of Florida and U. S. possessions in the Caribbean area. Additionally, the band 2160-2162 MHz is shared with stations in the Multipoint Distribution Service.

/2/ Except upon showing that no alternative frequencies are available, no new assignments will be made in the band 2160-2162 MHz for stations located within 80.5 kilometers (50 miles) of the coordinates of the cities listed in § 21.901(c) of this chapter.

/3/ Television transmission in this band is not authorized and radio frequency channel widths may not exceed 3.5 MHz.

/4/ Frequencies in this band are shared with fixed and mobile stations licensed in other services.

/5/ Frequencies in this band are shared with stations in the fixed-satellite service.

/6/ These frequencies are not available for assignment to mobile earth stations.

/7/ Frequencies in the band 2110-2120 MHz may be authorized on a case-by-case basis to Government or non-Government space research earth stations for telecommand purposes in connection with deep space research.

/8/ This frequency band is shared with station(s) in the Local Television Transmission Service and, in the U.S. Possessions in the Caribbean area, with stations in the International Fixed Public Radiocommunications Services.

/9/ The band segments 10.95 - 11.2 and 11.45 - 11.7 GHz are shared with space stations (space to earth) in the fixed-satellite service.

/10/ This band is co-equally shared with stations in the fixed services under Parts 74, 78 and 101 of the Commission's Rules.

/11/ Frequencies in this band are shared with Government stations.

/12/ Assignments to common carriers in this band are normally made in the segments 21.2 - 21.8 GHz and 22.4 - 23.8 GHz and to operational fixed users in the segments 21.8 - 22.4 GHz and 23.0 -23.6 GHz. Assignments may be made otherwise only upon a showing that no interference free frequencies are available in the appropriate band segments.

/13/ Frequencies in this band are shared with stations in the earth exploration satellite service (space to earth).

/14/ Frequencies in this band are shared with stations in the fixed-satellite and private operational fixed point-to-point microwave services.

/15/ Stations licensed as of September 9, 1983 to use frequencies in the 17.7 - 19.7 GHz band may, upon proper application, continue to be authorized for such operation.

/16/ Frequencies in this band are co-equally shared with stations in the Auxiliary Broadcasting (Part 74), Cable Television Relay (Part 78), Private Operational Fixed Point-to-Point Microwave (Part 101) and General Mobile Radio (Part 95) Services. Use of this spectrum for direct delivery of video programs to the general public or multi-channel cable distribution is not permitted.

/17/ Frequencies in these bands are shared with Government fixed stations and stations in the Private Operational Fixed Point-to-Point Microwave Service (Part 101).

/18/ Frequencies in the 942 to 944 MHz band are also shared with broadcast auxiliary stations (Part 74).

/19/ Frequencies in this band are shared with stations in the private-operational fixed point-to-point microwave service.

/20/ New facilities in these bands will be licensed only on a secondary basis. Facilities licensed or applied before January 16, 1992, are permitted to make modifications and minor extensions and retain their primary status.

/21/ Any authorization of additional stations to use the 2160-2162 MHz band for Multipoint Distribution Service applied for after January 16, 1992, will be secondary to use of the band for emerging technology services.

/22/ Frequencies in these bands are for the exclusive use of Private Operational Fixed Point-to-Point Microwave Service (Part 101).

/23/ Frequencies in these bands are for the exclusive use of Common Carrier Fixed Point-to-Point Microwave Service (Part 101).

/24/ Frequencies in these bands are available for assignment to television pickup and television non-broadcast pickup stations. The maximum power for the local television transmission service in the 14.2 - 14.4 GHz band is +45 dBW except that operations are not permitted within 1.5 degrees of the geostationary orbit.

/25/ Frequencies in these bands are available for assignment to television STL stations.

/26/ Frequency pairs 21.825/23.025 GHz, 21.875/23.075 GHz, 21.925/23.125 GHz, and 21.975/23.175 GHz may be authorized for low power, limited coverage, systems subject to the provisions of paragraph (s) hereof.

/27/ Frequencies in the 932 to 932.5 MHz and 941 to 941.5 MHz bands are shared with Government fixed point-to-multipoint stations and point-to-multipoint stations in the Public Land Mobile Service (Part 22). Frequencies in these bands are paired with one another and are available for point-to-multipoint transmission of the licensee's products and information services, excluding video entertainment material, to the licensee's customers.

Frequencies normally available for assignment in this service are set forth with applicable limitations in the following tables:

(b) 928 - 960 MHz Multiple address system (MAS) frequencies are available for the point-to-multipoint transmission of a licensee's products or services, excluding video entertainment material, to a licensee's customer or for its own internal communications. The paired frequencies listed in this section are used for two-way interrogate/response communications between a master station and remote stations. Each master station operating on these frequencies is required to serve a minimum of four separate active remote stations. Ancillary one-way communications on paired frequencies are permitted on a case-by-case basis. Ancillary communications between interrelated master stations are permitted on a secondary basis. The normal channel bandwidth assigned will be 12.5 kHz. Upon adequate justification, however, channels with bandwidths up to 50 kHz may be authorized. Tables 2, 4, and 6 list frequencies with 25 kHz bandwidth channels. When licensed for a larger bandwidth, the system still is required to use equipment that meets the ±0.00015 percent tolerance requirement. (See § 101.107). Any bandwidth (12.5 kHz, 25 kHz or greater) authorized in accordance with this subsection may be subdivided into narrower bandwidths to create additional (or sub) frequencies without the need to specify each discrete frequency within the specific bandwidth. Equipment that is used to create additional frequencies by narrowing bandwidth (whether authorized for a 12.5 kHz, 25 kHz or greater bandwidth) will be required to meet, at a minimum, the ± 0.00015 percent tolerance requirement so that all subfrequencies will be within the emission mask. When using subfrequencies, licensees are subject to the construction requirement of one master and four remotes per authorized bandwidth (12.5 kHz, 25 kHz or greater. Systems licensed for frequencies in these MAS bands prior to August 1, 1975, may continue to operate as authorized until June 11, 1996, at which time they must comply with current MAS operations based on the 12.5 KHz channelization set forth in this paragraph. Systems licensed between August 1, 1975, and January 1, 1981, inclusive, are required to comply with the grandfathered 25 kHz standard bandwidth and channelization requirements set forth in this paragraph. Systems originally licensed after January 1, 1981, and on or before May 11, 1988, with bandwidths of 25 kHz and above, will be grandfathered indefinitely.

(1) General Access Pool: Frequencies listed in this paragraph are available to all persons eligible under this Part for use in multiple address radio systems. Except as noted, however, the frequencies may be used by eligibles in the Power Radio Service only if the frequencies in subparagraph (2) of this Section are exhausted in the particular geographic area. The frequencies are also available for shared use by Part 22 Public Land Mobile Service users if frequencies listed in § 22.50(g) of this chapter are exhausted in the particular geographic area. Applications for use of these frequencies under Part 22 are subject to Part 101 requirements.

Table 1-Paired Frequencies (MHz)

(12.5 kHz bandwidth)

Remote transmit	Master transmit
928.00625	952.00625
928.01875	952.01875
928.03125	952.03125
928.04375	952.04375
928.05625	952.05625
928.06875	952.06875
928.08125	952.08125
928.09375	952.09375
928.10625	952.10625
928.11875	952.11875
928.13125	952.13125
928.14375	952.14375
928.15625	952.15625
928.16875	952.16875
928.18125	952.18125
928.19375	952.19375
928.20625	952.20625
928.21875	952.21875
928.23125	952.23125
928.24375	952.24375
928.25625	952.25625
928.26875	952.26875
928.28125	952.28125
928.29375	952.29375
928.30625	952.30625
928.31875	952.31875
928.33125	952.33125
928.34375	952.34375

Unpaired Frequencies (MHz)/1

(12.5 kHz bandwidth)

956.25625	956.33125	956.39375
956.26875	956.34375	956.40625
956.28125	956.35625	956.41875
956.29375	956.36875	956.43125

956.30625	956.38125	956.44375
956.31875		

/1/ Available to power eligibles regardless of whether frequencies in the power pool are exhausted.

Table 2-Paired Frequencies (MHz)

(25 kHz bandwidth)

Remote transmit	Master transmit
928.0125	952.0125
928.0375	952.0375
928.0625	952.0625
928.0875	952.0875
928.1125	952.1125
928.1375	952.1375
928.1625	952.1625
928.1875	952.1875
928.2125	952.2125
928.2375	952.2375
928.2625	952.2625
928.2875	952.2875
928.3125	952.3125
928.3375	952.3375

Unpaired frequencies (MHz)/1/

(25 kHz bandwidth)

956.2625	956.3375	956.4125
956.2875	956.3625	956.4375
956.3125	956.3875	

/1/ Available to power eligibles regardless of whether frequencies in the power pool are exhausted.

(2) Power Pool: Frequencies listed in this paragraph are available to persons eligible under § 90.63 of this chapter for licensing in the Power Radio Service for use in multiple address radio systems. After January 1, 1992, the frequencies are also available for

use by general access pool users and Part 22 Public Land Mobile Service users (§ 22.501(g) of this chapter) provided frequencies listed in their respective pools are exhausted in the particular geographic area. Applications for use of these frequencies under Part 22 of this chapter are subject to Part 101 of this chapter requirements.

Table 3-Paired Frequencies (MHz)

(12.5 kHz bandwidth)

Remote transmit	Master transmit
928.35625	952.35625
928.36875	952.36872
928.38125	952.38125
928.39375	952.39375
928.40625	952.40625
928.41875	952.41875
928.43125	952.43125
928.44375	952.44375
928.45625	952.45625
928.46875	952.46875
928.48125	952.48125
928.49375	952.49375
928.50625	952.50625
928.51875	952.51875
928.53125	952.53125
928.54375	952.54375
928.55625	952.55625
928.56875	952.56875
928.58125	952.58125
928.59375	952.59375
928.60625	952.60625
928.61875	952.61875
928.63125	952.63125
928.64375	952.64375
928.65625	952.65625
928.66875	952.66875
928.68125	952.68125
928.69375	952.69375
928.70625	952.70625
928.71875	952.71875

928.73125	952.73125
928.74375	952.74375
928.75675	952.75625
928.76875	952.76875
928.78125	952.78125
928.79375	952.79375
928.80625	952.80625
928.81875	952.81875
928.83125	952.83125
928.84375	952.84375

Table 4-Paired Frequencies (MHz)

(25 kHz bandwidth)

Remote transmit	Master transmit
928.3625	952.3625
928.3875	952.3875
928.4125	952.4125
928.4375	952.4375
928.4625	952.4625
928.4875	952.4875
928.5125	952.5125
928.5375	952.5375
928.5625	952.5625
928.5875	952.5875
928.6125	952.6125
928.6375	952.6375
928.6625	952.6625
928.6875	952.6875
928.7125	952.7125
928.7375	952.7375
928.7625	952.7625
928.7875	952.7875
928.8125	952.8125
928.8375	952.8375

(3) Frequencies listed in this paragraph are available for shared use by general access pool users for multiple address operations if frequencies listed in subparagraph (1) of

this section are exhausted in the particular geographic area: The frequencies are also available to eligibles in the power pool provided there are no other frequencies available for the type of operation contemplated. The frequencies in this pool may be assigned for paired or unpaired operation. If paired, the corresponding lower frequency is for remote unit use. Applications for these frequencies are subject to the conditions outlined in § 22.27 of this chapter.

Table 5-Public Mobile Service Category Frequencies (MHz)

(12.5 kHz bandwidth)

Remote transmit	Master transmit
928.85625	959.85625
928.86875	959.86875
928.88125	959.88125
928.89375	952.89375
928.90625	959.90625
928.91875	959.91875
928.93125	959.93125
928.94375	959.94375
928.95625	959.95625
928.96875	959.96875
928.98125	959.98125
928.99375	959.99375

Table 6-Public Mobile Service Category Frequencies (MHz)

(25 kHz bandwidth)

Remote transmit	Master transmit
928.8625	959.8625
928.8875	959.8875
928.9125	959.9125
928.9375	959.9375
928.9625	959.9625
928.9875	959.9875

(4) Frequencies listed in this paragraph are shared with stations in the Public Land Mobile Service (Part 22).

Table 7-Paired Frequencies

(12.5 kHz bandwidth)

Remote transmit	Master transmit
932.00625	941.00625
932.01875	941.01875
932.03125	941.03125
932.04375	941.04375
932.05625	941.05625
932.06875	941.06875
932.08125	941.08125
932.09375	941.09375
932.10625	941.10625
932.11875	941.11875
932.13125	941.13125
932.14375	941.14375
932.15625	941.15625
932.16875	941.16875
932.18125	941.18125
932.19375	941.19375
932.20625	941.20625
932.21875	941.21875
932.23125	941.23125
932.24375	941.24375
932.25625	941.25625
932.26875	941.26875
932.28125	941.28125
932.29375	941.29375
932.30625	941.30625
932.31875	941.31875
932.33125	941.33125
932.34375	941.34375
932.35625	941.35625
932.36875	941.36875
932.38125	941.38125
932.39375	941.39375
932.40625	941.40625